Remarks/Arguments:

Claims 1, 3, 5 and 8 have been amended. No new matter is introduced herein. Claims 2, 4, 7 and 9 have been cancelled. Claims 1, 3, 5, 6, 8, 10 and 11 are pending.

Claim 1 has been amended to include the features of claims 2 and 4. Claim 5 has been amended to include the features of claim 7 and 9. Claims 2, 4, 7 and 9 have been cancelled. Claim 1 has also been amended to clarify that the rectifier circuit is configured with a diode bridge circuit. Support for the amendments to claims 1 and 5 can be found, for example, at page 7, lines 7-15 and Fig. 1. Claims 3 and 8 have been amended to correspond to respective claims 1 and 5.

At paragraph 1, page 2 of the Office Action, the Examiner has objected to Fig. 6. In particular, the Examiner asserts that it does not include a Prior Art legend. Applicants respectfully note that Fig. 6 was amended in the Preliminary Amendment, filed on May 22, 2006, to include a Prior Art legend. Accordingly, Applicants respectfully request that the objection to Fig. 6 be withdrawn.

At paragraph 2, page 2 of the Office Action, the Examiner has objected to the drawings. In particular, the Examiner asserts that the feature of the "timer," the "refrigerating and air conditioning system," the "compressor in a refrigerating and air conditioning system" and the "blower" (recited in claims 8, 10 and 11) are not shown in the Figures. Applicants respectfully disagree. Applicants note that a timer is described on page 16, lines 16-20 with respect to position estimator 21, shown in Fig. 1 of the subject specification. The refrigerating and air conditioning system is represented by element 16-19 in Fig. 1 and is described on page 9, lines 3-12 of the subject specification. The compressor 16 is shown in Fig. 1 and described in the subject specification at page 9, lines 5-6. The blower is described on page 9, lines 10-13, with respect to condenser 17 or evaporator 19 that are shown in Fig. 1. Accordingly, the features cited by the Examiner in paragraph 2 of the Office Action are described in the specification with respect to Fig. 1. Thus, the objection is improper. Accordingly, Applicants respectfully request that the objection to the drawings be withdrawn.

Claims 1-3, 5-7 and 9-11 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Nakata et al. (U.S. 6,984,948) in view of Matsuo et al. (U.S. 6,906,491). Claim 4 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over Nakata et al. in view of Matsuo et al. and further in view of Sepe et al. "Fault Tolerant Operation of Induction Motor Drive with Automatic Controller Reconfiguration." Claims 2, 4, 7 and 9 have been cancelled. It is respectfully submitted, however, that the remaining claims are patentable over the cited art for the reasons set forth below.

Claim 1, as amended, includes features neither disclosed nor suggested by the cited art, namely:

> ... estimating the rotor position <u>by a position estimator when a voltage</u> between terminals of the capacitor <u>is lower than a predetermined voltage</u>, wherein the <u>rotor position is not detectable</u> by the position detector; and
>
> wherein the <u>capacitor has a capacitance</u> that a <u>ripple content</u> in an output voltage of the rectifier circuit <u>becomes not less than 90%</u> in an output range for practical use in driving the brushless DC motor. (Emphasis Added)

Claim 5 includes a similar recitation.

Nakata et al. disclose, in Fig. 1, a motor control apparatus including a control section 4 that detects current flowing to brushless motor 3 and drives/controls inverter circuit 2 (col. 7, lines 50-62). Nakata et al. also disclose, in Fig. 14, that a capacitor 16 having a small capacitance may be provided between rectifying circuit 1 and inverter circuit 2 (col. 16, lines 33-35). As described with respect to Fig. 1, a rotation phase is determined and used to generate application voltage commands (col. 8, lines 2-60). A rotation phase is either determined (if brushless motor 3 has a position sensor) or estimated (if brushless motor 3 does not have a position sensor) (col. 8, lines 2-8). If an input voltage detection value is smaller than a maximum application voltage, control section 4 applies a maximum voltage capable of being generated, without changing the phases of the applied voltages (col. 9, lines 17-44).

As acknowledged by the Examiner, Nakata et al. do not disclose or suggest estimating the rotor position by a position estimator when the rotor position is not detectable by the position detector. Thus, Nakata et al. cannot disclose or suggest Applicants claimed features of estimating the rotor position by a position estimator when a voltage between terminals of the capacitor is lower than a predetermined voltage, wherein the rotor position is not detectable by the position detector (emphasis added), as required by claims 1 and 5.

In addition, Nakata et al. do not disclose or suggest Applicants claimed features that the capacitor has a capacitance that a ripple content in an output voltage of the rectifier circuit becomes not less than 90% in an output range for practical use in driving the brushless DC motor (emphasis added), as required by claims 1 and 5. On page 4 of the Office Action, the Examiner asserts that Nakata et al. disclose that a capacitor has a capacitance that a ripple content in an output voltage of a rectifier circuit becomes not less than 90% in an output range for practical use. Applicants respectfully disagree. At col. 20, lines 1-6, Nakata et al. disclose that when "the brushless motor 3 is started, the input voltage of the inverter circuit 2 becomes similar to that obtained when the capacitor 205 is not provided since the capacitance of the capacitor 205 provided in the boosting circuit 21 is small." Nakata et al., however, do not disclose or suggest that a capacitor has a capacitance that a ripple content in an output voltage of a rectifier circuit becomes not less than 90% in an output range for driving the brushless DC motor, as required by claims 1 and 5. Thus, Nakata et al. do not include all of the features of claims 1 or 5.

Matsuo et al. disclose, in Fig 1, a motor controller including encoder 3 that is a feedback detector for position and velocity detection, magnetic pole position detection means 20, magnetic pole position estimation means 22 and magnetic pole position abnormality detection means 23 (col. 3, line 55 - col. 4, line 3). Magnetic pole position detection means 20 detects the magnetic pole position (from the feedback detector) and magnetic pole position estimation means 22 estimates a magnetic pole position of the rotor (from an induced voltage of the stator windings). Magnetic position abnormality detection means 23 detects the abnormality of the feedback detector by "always comparing" the detected and estimated magnetic pole positions. The estimated magnetic pole position is used when an abnormality is detected, to

supply electric power to the motor. (See col. 2, line 57 - col. 3, line 13 and col. 9, line 63 - col. 10, line 8).

Matsuo et al. do not disclose or suggest Applicants claimed features of estimating the rotor position by a position estimator when a voltage between terminals of the capacitor is lower than a predetermined voltage, wherein the rotor position is not detectable by the position detector (emphasis added), as required by claims 1 and 5. Instead, Matsuo et al. always compare detected and estimated magnetic pole positions in order to detect an abnormality. Thus, Matsuo et al. do not include all of the features of claims 1 or 5.

The remaining cited art do not make up for the deficiencies of Nakata et al. and Matsuo et al. because they do not disclose or suggest 1)estimating the rotor position by a position estimator when a voltage between terminals of the capacitor is lower than a predetermined voltage, wherein the rotor position is not detectable by the position detector or 2) where the capacitor has a capacitance such that a ripple content in an output voltage of the rectifier circuit becomes not less than 90% in an output range for practical use in driving the brushless DC motor.

Sepe et al. disclose, in Figs. 3 and 4, a torque error as a function of velocity or bus voltage of an encoder based controller and a sensorless controller (Section IV(A)). However, Sepe et al. are silent regarding estimating a rotor position by a position estimator when a voltage between terminals of a capacitor is lower than a predetermined voltage, where the rotor position is not detectable by a position detector. Thus, Sepe et al. do not include all of the features of claims 1 or 5. Accordingly, allowance of claims 1 and 5 is respectfully requested.

Claims 3, 6, 10 and 11 include all of the features of respective claims 1 and 5 from which they depend. Accordingly, these claims are also patentable over the cited art.

Claim 8 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over Nakata et al. in view of Matsuo et al. and further in view of Kushihara (U.S. 6,774,593). Claim 8, however, includes all of the features of claim 5 from which it depends. Kushihara et al. do not make up for the deficiencies of Nakata et al. and

Matsuo et al. Accordingly, claim 8 is also patentable over the cited art for at least the same reasons as claim 5.

The subject invention is directed to driving methods and drivers which drive a brushless DC motor by detecting a rotational position of a motor rotor of the brushless DC motor. The rotational position is detected based on a back electromotive force or a motor current of the brushless DC motor. For example, see Fig. 1 of the subject specification. The methods and drivers of the subject invention do not rely on a special position-detecting sensor, such as a hall element and encoder.

The present invention, as recited in claims 1 and 5, solves problems and provides advantages neither disclosed nor suggested by the cited art. As described at page 3, line 14 - page 4, line of the subject specification, a problem may occur when a capacitance of a smoothing capacitor (connected between terminals of a rectifier that is configured with a diode bridge circuit) is drastically reduced, in order to downsize the entire unit to the size of the driver. When the capacitance is reduced, it may cause a ripple content in an output voltage of the rectifier circuit to become not less than 90% in an output range for practical use in driving a brushless DC motor. For example, see page 12, lines 10-24 and Figs. 2 and 3 of the subject specification. When the capacitance is substantially reduced, a difference voltage between the instantaneous maximum voltage and the instantaneous minimum voltage may increase substantially. The difference voltage is applied to an inverter. Accordingly, if the difference voltage increases substantially, the back electromotive force used to detect the rotor position may become undetectable (or the motor current used to detect the rotor position may not flow) when a DC voltage applied to the inverter is low. The driving methods and drivers of the subject invention resolve the above-identified problem.

The subject invention includes a position estimator which estimates the rotational position of the motor rotor, when a voltage between terminals of the capacitor is lower than a predetermined voltage, and where the rotor position is not detectable by the position detector. Accordingly, in addition to the position detector that detects the rotational position of the motor rotor (based on a back electromotive force of the brushless DC motor or a motor current), the subject invention also

includes a position estimator to estimate the rotor position. Thus, the position estimator can be applied, instead of the position detector, when a voltage between terminals of the capacitor is lower than a predetermined voltage, where the rotor position is not detectable by the position detector.

In contrast, the cited references do not disclose or suggest the above-identified problem that decreasing the capacitance of the capacitor causes the back electromotive force used to detect the rotor position to be undetectable (or that the motor current used to detect the rotor position does not flow), when a DC voltage applied to the inverter is low. Because the cited art do not acknowledge the above-identified problem, the cited art cannot disclose or suggest driver methods or drivers that solve the above-identified problem. The subject invention includes driver methods and drivers to control the inverter by selecting between detection or estimation of the rotational position. The subject invention uses a position estimator instead of a position detector when the voltage between terminals of the capacitor is lower than a predetermined voltage, where the rotor position is not detectable by the position detector. Accordingly, claims 1 and 5 include features, solve problems and have advantages neither disclosed nor suggested by the cited art.

In view of the foregoing amendments and remarks, the above-identified application is condition for allowance which action is respectfully requested.

Respectfully submitted,

Lawrence E. Ashery, Reg. No. 34,515
Attorney for Applicants

DMG/so

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P.O. Box 980
Valley Forge, PA 19482-0980
(610) 407-0700

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